THE

CRUSHED STONE JOURNAL

Official Publication

The National Crushed Stone Association

In This Issue—

APRIL, 1929

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WHY HAVE LOSSES

Poor Grading—High Overhead—Troubles

Ask the following stone producers why they are using NIAGARA ROLLER BEARING SCREENS year after year

Solvay Process Company	Jamesville, N. Y.
Solvay Process Company	Syracuse, N. Y.
Rock-Cut Stone Company	Auburn, N. Y.
Rock-Cut Stone Company	Ballina, Madison Co., N. Y.
Rock-Cut Stone Company	Jamesville, N. Y.
Rock-Cut Stone Company	Lacona, N. Y.
Rock-Cut Stone Company	Watertown, N. Y.
Mohawk Limestone Products Company	Mohawk, N. Y.
Mohawk Limestone Products Company	Jordanville, N. Y.
Mohawk Limestone Products Company	Mount Vision, N. Y.
BUFFALO Crushed Stone Company	Buffalo, N. Y.
Federal Crushed Stone Company	Cheektowaga, N. Y.
Genesee Stone Products Company	Stafford, N. Y.
LeRoy Lime and Crushed Stone Company	LeRoy, N. Y.
Ribstone Concrete Products	LeRoy, N. Y.
Dolomite Products Company	Rochester, N. Y.
General Crushed Stone Company	Oaks Corners, N. Y.
General Crushed Stone Company	North LeRoy, N. Y.
General Crushed Stone Company	Glenmills, Penna.
Wagner Quarries	Sandusky, Ohio
Wagner Quarries	Castalia, Ohio
Dolomite, Inc.	Maple Grove, Ohio
Herzog and Sons	Forest, Ohio
Ohio Blue Limestone	Marion, Ohio
National Lime & Stone Co.	Spore, Ohio
National Lime & Stone Co.	Carey, Ohio
National Lime & Stone Co.	Lewisburg, Ohio
National Lime & Stone Co.	Bluffton, Ohio
Belle Center Stone Co.	Belle Center, Ohio
Higgins Stone Company	Bellevue, Ohio
Lake Erie Limestone Company	Youngstown, Ohio
Lake Erie Limestone Company	Lowellville, Ohio
Lake Erie Limestone Company	Hillsville, Pa.
Lima Stone Company	Lima, Ohio
Spencer Stone Company	Spencerville, Ohio
Union Limestone Company	Youngstown, Ohio
Ohio Marble Company	Piqua, Ohio
C. C. Beam	Melvin, Ohio
Rock Products Company	Toledo, Ohio
France Stone Company	Holland, Ohio
France Stone Company	Monroe, Mich.
Swint Stone Company	Fremont, Ohio
J. E. Baker Company	Bainbridge, Lancaster Co., Pa.
J. E. Baker Company	White Hall, Baltimore, Md.
New Castle Lime & Stone Company	New Castle, Pa.
New Castle Lime & Stone Company	Dunbar, Pa.
Lehigh Stone Company	Ormrod, Pa.
Stowe Trap Rock Company	Pottstown, Pa.
Carbon Limestone Company	Hillsville, Pa.
Blue Stone Quarry Company	Gwynedd Valley, Pa.
Whiterock Quarries	Pleasant Gap, Pa.
Connecticut Quarries Company	Rocky Hill, Conn.
New Haven Trap Rock Company	New Haven, Conn.
Edward Balf Company	Hartford, Conn.
John S. Lane and Son	Westfield, Mass.
West Roxbury Trap Rock Company	West Roxbury, Mass.
Old Colony Crushed Stone Company	Quincy, Mass.
Rowe Contracting Company	Malden, Mass.
Simbrico Stone Company	West Roxbury, Mass.
Casper Stolle Quarry & Construction Co.	East St. Louis, Ill.
Consumers Company	Lemont, Ill.
Federal Stone Company	LaGrange, Ill.
Michigan Limestone & Chemical Company	Rogers City, Michigan
Biesanz Stone Company	Winona, Minn.
Meshberger Bros. Stone Company	Berne, Ind.
Hy-Rock Products Company	Marengo, Ind.
Fanwood Stone Crushing & Quarry Co.	Fanwood, N. J.
Samuel Braen	Patterson, N. J.
Orange Quarry Company	West Orange, N. J.
Granite Rock Company	Logan, Calif.
Daniel Contracting Company	San Francisco, Calif.
Deitz Hill Development Company	Kansas City, Mo.
Rock Hill Quarries Company	St. Louis, Mo.
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Franklin Limestone Company	Nashville, Tenn.
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Coast Quarries	Vancouver, B. C.
Dufferin Construction Company	Innerkip, Ont.
Gordon Crushed Stone Company	Hagersville, Ont.
Thomas Langton Crushed Stone	Coldwater, Ont.
LaCie A. Desrosiers, Ltd.	Montreal, Que.
Puslinch Quarries, Ltd.	Puslinch, Ont.
Quinn Stone and Ore Company	Ft. William, Ont.
Rigand Granite Products Company	Rigand, Que.
Stone and Son	Ingersoll, Ont.
Standard Lime Company, Ltd.	Joliette, Que.
Walker Bros.	Thorold, Ont.
Warden King Company, Ltd.	Montreal, Que.

LET US FIGURE YOUR PROBLEMS]

NIAGARA CONCRETE MIXER CO.

40 PEARL STREET

BUFFALO, N. Y.

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The Effect of Variations in Gradation of Crushed Stone on Concrete Strength

BY A. T. GOLDBECK,

Director, Bureau of Engineering, National Crushed Stone Association

Introduction

IN the November, 1928, issue of The Crushed Stone Journal an article was published entitled, "The Effect of Gradation of Crushed Stone on the Percentage of Voids." It was shown that the lowest percentage of voids in crushed stone is obtained when the medium size pieces are omitted. For the sake of convenience two of the original diagrams are repeated here as Figs. 1 and 2. Incidentally, these figures are slightly differ-

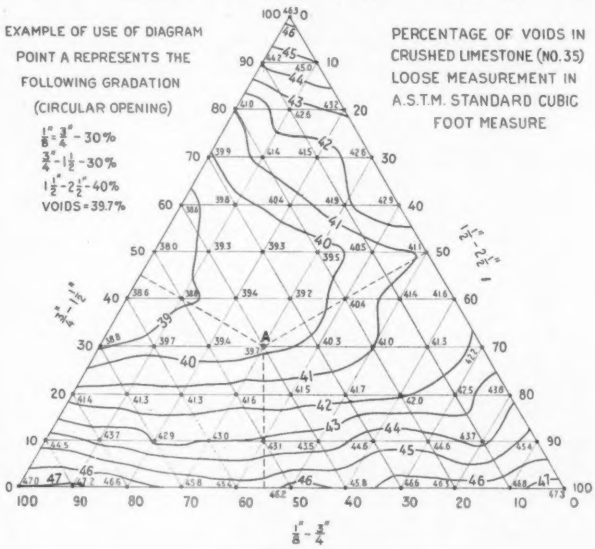


FIG. 1

ent from those originally published owing to the correction of several values which were found to be in error.

The diagrams are self-explanatory after a little study. It will be noted that the lowest percentage of voids in the crushed stone in a loose condition was 38.0 and this low value was obtained in stone made up of—

50 per cent of $1/8$ to $3/4$ in.
0 per cent of $3/4$ to $1\frac{1}{2}$ in.
50 per cent of $1\frac{1}{2}$ to $2\frac{1}{2}$ in. size

as determined by round opening screens. Similarly, the lowest percentage of voids in the same kind of stone in a rodded condition (material compacted in a cubic foot measure by the use of a steel rod) was 33.9 and this value was obtained when the stone had—

40 per cent of $1/8$ to $3/4$ in.
0 per cent of $3/4$ to $1\frac{1}{2}$ in.
60 per cent of $1\frac{1}{2}$ to $2\frac{1}{2}$ in. size

It was further pointed out in the article above referred to, that although the lowest percentage of voids

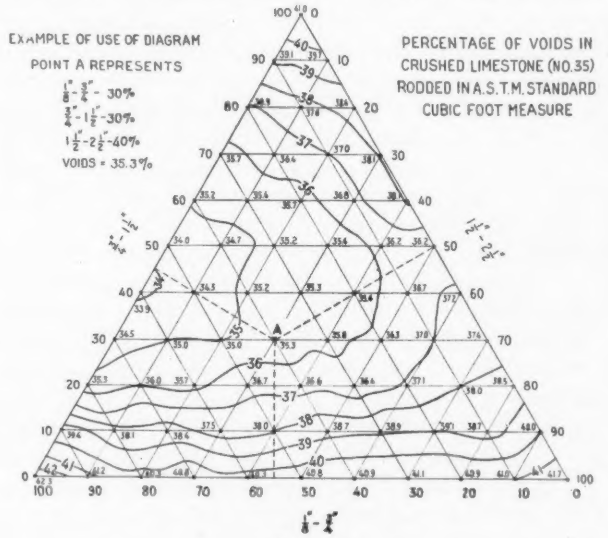


FIG. 2

is obtained by the use of stone which is lacking in intermediate size material, none the less the percentage of voids will be increased only one or two per cent when a considerable proportion, up to 30 or 40 per cent, of intermediate size material is included. These void determinations have practical significance because of the tendency toward better gradation of aggregates and especially because of the encouragement lent in this direction by the United States Bureau of

Public Roads through a recent memorandum which encourages the use of certain principles in concrete proportioning. These principles have already been stated in the November, 1928, issue of The Crushed Stone Journal. Principle 3 is re-stated here for convenience.

> Principle 3. The scientific grading of coarse aggregate by combination of separated sizes in each batch in the proportions which will produce the maximum practicable density.

This principle, if universally adopted would require that aggregate producers ship their stone in separated sizes rather than in the form of a well-graded mixture. Obviously, when identical volumetric proportions are used, a higher yield of concrete or a lower cement content per cubic yard will be obtained, the lower the percentage of voids in the stone. Since the cement is the most expensive ingredient in the concrete, it would seem economical to use stone so graded as to have the lowest possible percentage of voids. As will be pointed out later, however, that gradation producing the lowest void content does not seem to give the best results in concrete nor is it an economical gradation from the standpoint of aggregate production. However, because of the present trend in concrete proportioning methods it is important that stone producers become fully acquainted with the effect of variations in gradation on percentage of voids. Further, it is important that the engineer know what effect coarse aggregate of various gradations has on the properties of concrete.

If an engineer were highly technical, and if he ignored the many practical considerations in the production of crushed stone, he might require aggregate so graded as to give the minimum obtainable percentage of voids irrespective of all other considerations. In this gradation the intermediate sizes would be lacking. The test results given in the November, 1928, issue of The Crushed Stone Journal show the fallacy of writing such a specification for gradation. They strongly indicate that a more practical specification would permit a range of 30 to 40 per cent in intermediate size particles, for it is found that even as wide a range as this does not materially increase the percentage of voids above the minimum obtainable.

Purpose of Investigations

Since aggregate is used in concrete, the full story of effect of gradation is not told until it includes the effect of variation in gradation on the concrete and it is the purpose of this article to indicate, at least, what effect variations in gradation of crushed stone have on the properties of concrete, provided the gradation of the stone is maintained within limits which will result in a low percentage of voids in all cases.

Gradations Used

Because it was necessary to prepare rather large quantities of aggregates graded to particular sizes for use in making concrete test specimens and, further, because of the character of our screening equipment we used square opening screens in the present investigation although our previous work on voids was done with round opening screens.

Twelve gradations of stone were used as follows:

TABLE I—GRADATIONS USED

	Per cent											
No.	1	2	3	4	5	6	7	8	9	10	11	12
2 —1¼	42	40	60	20	30	40	50	70	50	60	80	70
1¼— ½	41	20	0	50	40	30	20	0	30	20	0	20
½—No. 4	17	40	40	30	30	30	30	30	20	20	20	10
Weight in Pounds per Cubic Foot (loose volume)												
	96.6	96.9	98.6	94.8	95.9	96.5	98.2	99.2	96.4	97.2	97.9	95.9
Per cent Voids												
	43.7	43.6	42.6	44.7	44.2	43.8	42.8	42.3	43.8	43.4	43.0	44.2

These gradations are plotted in Fig. 3.

PROJECT I-3
MECHANICAL ANALYSES OF COARSE AGGREGATES USED IN STRENGTH TESTS

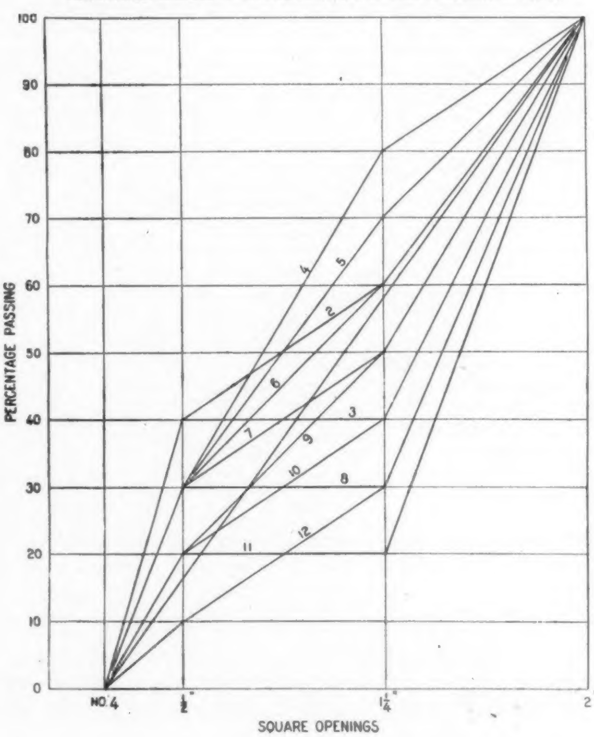


FIG. 3

These particular gradations were selected because they lie within the range having the lowest percentage of voids as shown by our previous investigations. The minimum percentage of voids was obtained with gradation No. 8 in which there is no intermediate size material and the next lowest in gradation No. 7, containing 20 per cent of intermediate size material. The range in percentage of voids is from 42.3 to 44.7, or 2.4 per cent. The diagram of gradation covers a rather wide field, as far as intermediate size of particles is concerned, but the maximum and minimum sizes were maintained constant in all cases. The loose weight per cubic foot of limestone having the above gradations was obtained by the use of the standard American Society for Testing Materials cubic foot measure, and the specific gravity of the stone, 2.75, was determined by the over-flow method. Percentage of voids was calculated by the well-known formula:

$$\text{Percentage of voids} = 100 \left\{ 1 - \frac{\text{Wt. per Cu. Ft.}}{\text{Ap. Sp. Gr.} \times 62.4} \right\}$$

The fine aggregate used was Massaponax sand having the following gradation:

MECHANICAL ANALYSIS MASSAPONAX SAND

Sieve No.	Per cent Retained	
4	2	Fineness Modulus= 3.02
8	23	Wt. per Cu. Ft. Loose=103.1
16	38	Rodded=108.5
30	56	Strength Ratio, 7 days=160
50	86	
100	97	
200	99	

Concrete Mixtures

The usual precautions of thorough mixing of the cement to insure uniformity were taken as a matter of course. Mixtures containing stone having the 12 gradations above shown were made in the proportions of 1:2:3½ by loose, dry, volume. One 6 x 6 x 36-in. beam and two 6 x 12-in. cylinders were made for each gradation on each of three days. All of the mixes are strictly comparable in that they were all subjected to identical curing conditions. The specimens were stored in a moist room at 70°F. until tested at the end of 28 days.

In Table II are shown the properties of the concrete and the strength results obtained. The beams were tested as simple beams on a 20-inch span with a single load applied at the center. In all cases an effort was made to keep the workability constant as determined by the flow table, and this was accomplished within a reasonable range. The workability of the mixture was also noted by the operator, determined on the basis of his judgment of the ease of placing and finishing the concrete in the specimens. The numbers in the column headed "workability" have the following meaning:

1. Excellent
2. Good
3. Medium
4. Poor
5. Very poor

TABLE II—PROPERTIES OF CONCRETE[1]

No.	Total Water	Wt. per Cu. Ft.	Flow	Workability	Water cement[2]	Bags of cement per Cu. Yd.	Combined Fineness Modulus	Crushing Strength	Modulus of Rupture
1	13.1	154.5	159	3	0.63	6.13	5.57	4090	701
2	14.3	154.1	161	2—3	0.69	6.05	5.45	4010	691
3	13.7	154.3	163	2+	0.66	6.03	5.58	4000	733
4	14.1	153.7	162	2	0.68	6.11	5.36	4060	758
5	14.1	153.6	163	2	0.68	6.07	5.43	4110	724
6	13.8	154.2	166	2	0.66	6.09	5.50	4170	767
7	13.9	153.7	168	2	0.67	6.01	5.55	4300	745
8	13.8	153.9	172	2+	0.66	6.00	5.69	3910	763
9	13.8	154.9	169	2+	0.66	6.12	5.60	4180	774
10	13.6	154.7	163	2+	0.65	6.09	5.66	4010	785
11	13.4	154.5	174	2—3	0.64	6.06	5.79	3970	724
12	13.2	154.5	167	3	0.63	6.13	5.78	4010	725

[1] Coarse Aggregate: Limestone No. 35, Sp. Gr. 2.75, 3.3% wear, Sand, Massponax No. 48

[2] W/C—Water cement ratio, i. e; ratio of volume of water to volume of cement.

It will be noted that the number of bags of cement per cubic yard varies only from 6.0 to 6.13; a range of

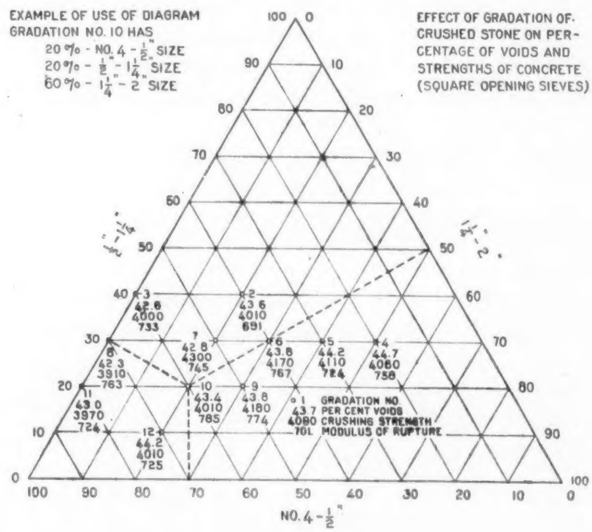


FIG. 4

0.13 of a bag and this was to be expected because of the small range in percentage of voids in the coarse ag-

gregates, notwithstanding the wide range in gradation of these aggregates. This is merely another way of saying that practically no saving in cement is to be brought about by requiring that the stone be graded strictly within narrow limits. And particularly is it to be noted by engineers, that the saving in cement in gradation No. 8, which has the minimum percentage of voids and in which there is no intermediate size material, is practically negligible as compared with mixtures which do have intermediate size material in them.

The engineer will also be interested in knowing what effect these gradations have on the strengths of the respective concretes. The strength results have been plotted on a triaxial diagram, (Fig. 4) and apparently mixtures 3, 8 and 11, which are the mixtures containing no intermediate size material, are those having the lowest compressive strengths although high transverse strengths. Apparently the materials lying in the zone of the highest compressive strength have 20 to 30 per cent of ½ to 1¼ in. fragments and from 20 to 30 per cent of No. 4 to ½ in. fragments. The range in strength results is as follows:

TABLE III—RANGE IN STRENGTH RESULTS

	Compressive Strength	Modulus of Rupture
High Value	4300	785
Low Value	3910	691
Ratio High/Low	1.10	1.14

It is interesting to note that the highest value for modulus of rupture is not obtained with the mixture which gives the highest compressive resistance. The best all-around results seem to occur in aggregates Nos. 6, 7 and 9. Of these No. 7 has the lowest cement factor and likewise good workability.

The test results reported herewith are too meager to be conclusive but, at least, they indicate the following:

Indication from Tests

That a considerable percentage of intermediate size material may be used in coarse aggregate without increasing the percentage of voids more than a few per cent and without appreciably altering the cement factor or concrete strengths.

Conclusion

In conclusion, it is pointed out that from the standpoint of stone production, it is undesirable that any gradation be specified which results in a waste of material such as would occur in many cases if the so-called "gap" grading, as typified by gradings 3, 8 and 11 is used. Such gradations would necessitate the screening out of ½ in. to 1¼ in. material and the storage of this size until disposal. Fortunately, the test results show that this needless expense is unnecessary.

Very roughly, the run of the crusher coincides with gradation No. 1, with variations depending upon the characteristics of the rock. Obviously, a specification requiring approximately such a gradation would result in economy in stone production and the test results indicate that merely by a slight departure from the straight line gradation, through the omission of a comparatively small amount of the intermediate size, very favorable concrete results are obtained. Gradations Nos. 9 and 10 illustrate the above point.

One of the important features of all concrete construction, and especially so of concrete road construction, is uniformity from batch to batch. It is desirable that the gradation of the coarse aggregate be kept fairly uniform because of its effect on the workability of the concrete, on the water content and on the cement factor.

My message to the engineer, who is contemplating requiring the shipment of aggregate in separated sizes, is that there are other things to consider than the academic requirement of gradation to obtain the minimum percentage of voids. One of these considerations is economy in coarse aggregate production. The production of aggregate having the minimum percentage of voids results in the discarding of intermediate size material. This is uneconomical and, moreover, a gradation permitting the use of the intermediate size has an almost negligible effect on the percentage of voids in the coarse aggregate and on the strength values of the resulting concrete. Apparently, then, the practical results desired, namely, high concrete strengths and economical concrete, may be obtained without the necessity of uneconomical stone production which would occur were it necessary for the producer to screen out and store up until disposed of, a large quantity of intermediate size stone.

To the stone producer, let me point out the desire of the engineer to produce uniform concrete and in this the producer may aid materially by taking all of the necessary precautions to supply crushed stone having as uniform a gradation as possible during the entire course of construction work.

Crushed Stone for Sewage Trickling Filters[1]

By George B. Gascoigne,
Consulting Sanitary Engineer, Cleveland, Ohio

FOR many years producers of crushed stone have found that when the requirements of the highway, railroad and concrete engineer were satisfied, their entire output generally was accepted without further question. During the past two decades, however, the demand for crushed material in the field of public health engineering, especially for coarse grained sewage filters, has been of sufficient magnitude that the requisites of the sanitary engineer had to be given some attention also. Furthermore, within the past five years, the need for satisfactory coarse material for sewage filters has been greatly emphasized, and the necessity for research in this connection has been regarded of sufficient importance to be accorded national recognition. This is evidenced by the fact that four years ago the American Society of Civil Engineers appointed from the Sanitary Engineering Division a Committee on Filtering Materials for Water and Sewage Works. Up to the present time most of the work of this Committee, of which the writer is a member, has been directed toward determining what constitutes a suitable material for sewage trickling filters, and just how this can be done by laboratory procedure, especially where the results of satisfactory service of any proposed material are not available.

Fundamental Requirements

It is entirely within reason for the producer of crushed stone to enquire what there is about filtering sewage which demands a special material. This may be better understood if the structure and function of a trickling filter are briefly outlined.

As ordinarily constructed, a trickling filter consists of from six to ten feet of crushed material, contained within walls of earth, masonry, or concrete, and overlying a free drainage system. The sewage, usually clarified by previous settling, is applied evenly over the surface and trickles down through the so-called filtering material to the underdrains. During its passage downward it comes in contact with gelatinous bacterial growths on the surface of the individual pieces of filtering material, and becomes changed from an offensive to an inoffensive liquid. In a filter which operates normally the retained solids slough off periodically by natural means, thus keeping the filter clean.

For continuous and successful operation of a trickling filter, there must be an abundant supply of oxygen or air throughout its entire mass. To assure the free circulation of air it is obvious that the filtering material must contain a substantial percentage of voids. In order that the voids may be maintained at all times, a suitable trickling filter material must conform to three basic requirements, which should cover continuous service over a period of years.

It must be durable, that is, it must not disintegrate.

It must not pack or cement together.

It must have surfaces which are rough enough to retain the bacterial jelly, and at the same time not too rough to prevent the periodic sloughing off of the stored solids.

Ordinarily, if a material will meet the first requirement of durability or permanence, the others will follow as a matter of course, provided the material was of proper size and cleanliness when placed. It may be said, therefore, that the soundness of the material used in trickling filters is the first essential.

Destructive Agencies

Soundness is a requisite of crushed stone used for other purposes. However, the forces which disrupt are more pronounced and their influence more greatly manifested in a sewage trickling filter than in other structures. The principal cause for the disintegration of trickling filter media is the alternate freezing and thawing during winter operation. As ordinarily applied to the filters, sewage is sprinkled for 5 or 6 minutes and then there is a rest period of 10 or more minutes, after which the sprinkling begins again. During the rest period in cold weather, the surface material freezes. When the relatively warm sewage, which rarely falls below 40° F., is being sprinkled, the

[1] Presented at the Twelfth Annual Convention of the National Crushed Stone Association, Cleveland, Ohio, January 21-24, 1929.

frozen surface is thawed. In twenty-four hours there may be as many as fifty of these freezings and thawings. It may be seen, therefore, that some materials which may withstand natural weathering for a considerable period of time, may be reduced to fines in short order under the intensive freezing and thawing occurring during winter operation of trickling filters.

Other destructive effects, such as hydration, oxidation of iron, and chemical solution, may occur to a greater or less degree, dependent upon the particular composition of the material used and of the sewage applied. At present, attention in this respect seems to be centered upon the sudden and wide changes in temperature.

Desirable Properties of Suitable Material

From the above discussion, it may be concluded that any material which will resist disintegration, which will not cement or pack together after placing, and which will permit of a periodic sloughing off of the stored solids, should prove satisfactory. It is obvious that uniform sizing, cleanliness and proper placing are highly important irrespective of the type of material. In this connection much progress has been made during the past few years in crushing and screening plants, toward securing desired grading. Also, the increased use of washing devices indicates the importance attached to cleanliness, and furthermore, methods of handling and placing have vastly improved, so that with modern equipment, the properly sized, clean material as shipped from the point of production can be put into place with a minimum of segregation and breaking up. However, we still have too many fines and serious consideration is being given to the necessity of additional screening at the site of the work.

Suitable material, therefore, should consist of sound, durable, non-friable substances, with a favorable history as regards natural weathering. It should be clean, free from dust, dirt and other foreign substances, and should conform within defined tolerances to certain specifications as to size and grading.

How Can Suitable Material Be Secured

Your organization is interested principally in finding out, first, what are the requirements for satisfactory trickling filter material, and secondly, how can the suitability of any proposed material be determined before it leaves the point of production.

Specifications and laboratory tests to determine the acceptability of crushed stone for concrete and highway work are fairly well established. Observation and experience have shown, however, that a crushed product which by test and service may be found satisfactory for ordinary use, may prove a failure when used in sewage filters. For example, in most cases, it appears that the lower the percentage of absorption, the more preferable the material. However, some of the most conspicuous cases of disintegration have been found in materials having almost negligible absorption. On the other hand, other materials showing high absorption have been found to remain intact after long periods of test and service. Determinations of specific gravity are useful largely in classifying materials, and calculating weight. Hardness, toughness and abrasion tests afford scant information as to the performance of a material after it is in place. Chemical composition, also, except in special instances, appears to throw relatively little light on service behavior. It appears, therefore, that the determination of soundness is of most significance in passing upon the suitability of filter material, viewed solely from the standpoint of permanence. Obviously this test will not give any information relative to cementing or consolidating or to its ability to slough off solids, the so-called unloading. With these facts in mind, it appears evident that due consideration must be given to establishing a practical and reliable test to predict soundness.

Testing for Soundness

The actual freezing and thawing of samples would appear to be the best method of testing for soundness. However, this method is tedious, laborious and time consuming. Accordingly, a method of testing is now generally used in which the destructive effects of actual freezing and thawing are closely paralleled, but made apparent in a much shorter time. This is called the sodium sulphate test, and at the present time appears to furnish the best information indicative of actual service performance.

In brief, as usually conducted, this test consists first in soaking the pieces of material for twenty hours in a saturated solution of sodium sulphate at room temperature. The soaked material is then taken from the sodium sulphate solution and placed in a drying oven maintained at 100-105° C. for four hours. After drying, the material is reimmersed in the solution and the soaking and drying processes repeated. One soaking and one drying constitute a cycle. Examination of the pieces is usually done just previous to drying. Any checking, spalling, cracking or other signs of disintegration or failure are noted and recorded.

Interpretation of Results

When pieces of crushed stone are subjected to the sodium sulphate test, various effects may be noted, such as the flaking and spalling off of small particles; rounding or crumbling of the edges, faint cracks which may be only on the surface; cracks which gradually increase and eventually cause a splitting up into two or possibly more pieces; cracks opening along laminations or seams; radiating cracks which increase to the point of effecting a shattering into many pieces; and finally, a "blowing up" of the material which reduces it to mud or else to particles so fine that the individuality of the pieces is lost.

Extreme care and experienced judgment must be exercised in interpreting the results noted. A piece of stone which merely splits into two pieces cannot be considered as failing to the extent of one which is shattered into many pieces. Also one or two fine cracks and slight spalling where the piece as a whole remains sound, cannot be regarded as being so detrimental as the cracking of a piece into several layers along seam lines. However, a piece which exhibits excessive spalling or crumbling at the edges must be viewed with suspicion.

With the information now available, it appears that in general if a piece of material shows relatively little "fines" by spalling or crumbling at the edges, and remains sound at the end of twenty cycles, notwithstanding the fact that a single splitting may have occurred, it is regarded as being satisfactory for trickling filters, from a disintegration standpoint. On the other hand, a piece of material which exhibits disintegration, marked checking or cracking, or is split into three or more separate pieces, or is so cracked that it is evident that it will do so, is considered a failure.

Relaxation Permitted

It is evident that any material will contain some portion which will not pass test. No quarry or other source of supply runs as uniform as desired. Consequently, it is thought that consideration should be given to the including of some unsatisfactory material, although there are many who do not look upon the procedure with favor. This question is now being studied, as is also that of determining the effect of the roughness or smoothness of particles in respect to the ability of a material to unload.

General Considerations

Public opinion is fast crystallizing into a demand for better sanitation. Our streams must be cleaned up. The elimination of pollution by municipal sewage and industrial wastes will necessitate the construction of sewage treatment plants. Without doubt many of these plants will include trickling filters. A filter should last indefinitely. Consequently, the filtering material must be of the best. In order that the purchaser may be properly protected and at the same time the producer saved from unnecessary inconvenience and expense, intensive study is now being directed toward formulating definite specifications as to what constitute suitable material, and to the development of laboratory test procedures whereby the suitability in actual service may be reliably predicted. The results of this investigation should be available for general use within the next two years.

Grade Crossings Eliminated from Federal Aid Highways

A TOTAL of 390 railroad grade crossings were eliminated from the Federal Aid Highway System in 1928, it was stated April 22 by the Bureau of Public Roads, Department of Agriculture.

The full text of the statement follows:

Grade crossings are eliminated in two ways—by grade separation by means of the underpass, and by relocation of highways. Of the 390 crossings eliminated in 1928, 107 were grade separations and 283 were excluded by relocation of highways.

According to figures of the Bureau, covering the period 1917 to December 31, 1928, a total of 4,291 crossings have been eliminated on the Federal Aid System with Federal aid—947 through-grade separations, and 3,344 through relocation of highways.

For the year 1928 Wisconsin heads the list of eliminations, with a total of 35. Alabama is second with 31; Michigan, third with 26; Texas, fourth with 25; Indiana, fifth with 24; Kansas, sixth with 23, and Montana, seventh with 22. Georgia and Illinois each are credited with 21, and Mississippi with 17.

For the period from 1917 through 1928 Texas heads the list with a total of 440 eliminations. Minnesota is second with 321; Iowa, third with 212; Wisconsin, fourth with 204; North Dakota, fifth with 193; Georgia, sixth with 182; Oklahoma, seventh with 162; Illinois, eighth with 161; Kansas, ninth with 153, and North Carolina, tenth with 132.

The Foundation of a Major Injury[1]

By H. W. Heinrich

Assistant Superintendent, Engineering and Inspection Division, The Travelers Insurance Company

THE individual employers who constitute the membership of the National Crushed Stone Association, in 1929, enter a new era in business,—an era in which keen competition, high speed, greater production, better product and attention to detail are all more vitally important than in other years. These factors all have a bearing upon economic operation and ultimately upon profits, and all of them are directly affected by the occurrence of accidents. Whether the members of this Association carry compensation insurance or whether they are self-insurers, it can be closely estimated that the cost to them of compensation claims and medical treatment because of industrial accidents is over 2% of their total payroll, and that the total cost of accidents which they must bear, including incidental or hidden expenses such as come about in the training of men to replace those who are injured, in spoilage, breakage, waste and delays, in lost time, weakened morale and other conditions that result from accidents, is five times as great or 10% of the payroll.

Accident prevention is therefore an economic problem of tremendous significance to the National Crushed Stone Association not only because of its high cost but because that cost can undoubtedly be reduced at least 50%.

It is my purpose to point out a practicable method whereby such a reduction may be secured.

Accident prevention has been (and is even now) based largely upon an analysis of the causes leading to a *major accident*. This situation in accident prevention exists, for the most part, because of a misunderstanding of what an accident really is. As a rule, precise terminology is of relatively small importance, except when we find that the terminology of a subject illustrates misdirection in both thought and action. Then, a mere matter of words or phrases becomes decidedly important.

Throughout industry, reference is made to *major* and *minor* accidents. The two are definitely segregated. No-accident contests and campaigns are usually based upon lost-time or major-accident frequency. Tables and statistics feature lost-time accidents (or others in the so-called major group) that involve fatalities, fractures, dismemberments, and other serious injuries, and, in general, attention is centered upon these more spectacular occurrences to the exclusion, in part at least, of adequate consideration of minor accidents. Not only is this true with regard to cause-and-type analysis and tabulation, but also subsequent action in prevention work follows along the same line and is based upon a relatively small number of major accidents.

The expression "major or minor-accidents" is misleading. In one sense of the word there is no such thing as a major *accident*. There are major and minor *injuries*, of course, and it may be said that a major accident is one that produces a major injury. However, the accident and the injury are distinct occurrences; one is the result of the other, and in the continued use of the expression "major accident," and in the acceptance of its definition as one that results seriously, there is a decided handicap to effective work. In reality, when we so merge the terms "accident" and "injury," we are assuming that no accident is of serious importance unless it produces a serious injury. Yet thousands of accidents having the potential power to produce serious injuries do not so result. There are certain types of accidents, of course, where the probability of serious injury may vary in accordance with circumstances. For example, a type of accident such as a "fall," if occurring on a level field of soft earth or on a rug-covered floor in the home, may not be potentially as serious as the fall of a steel erector on the top of a skyscraper. Yet, the former may (and often does) result in a severe injury.

In any case, in prevention work the importance of any individual accident lies in its *potential power* to create injury, and *not* in the fact that it actually does or does not so result. Therefore, when we arbitrarily select lost-time or so-called major accidents for study, as a basis for records and for guidance in prevention work, we are often misdirecting our efforts, ignoring most valuable data, and unnecessarily limiting our statistical exposure.

An injury is merely the result of an accident. The accident itself is controllable. The severity or cost of an injury which results when an accident occurs is, to an extent, difficult of control. It depends upon many uncertain and, to an extent, unregulated factors—such

[1] Presented at the Accident Prevention Conference, Twelfth Annual Convention, National Crushed Stone Association, Cleveland, Ohio, January 23, 1929.

as the physical or mental condition of the injured person; the weight, size, shape, or material of the object causing the injury; the portion of the body injured; and so on. Why, then, should we continue to direct our attention to *injuries* rather than to the *accidents* which cause them? I assert that this is exactly what we are doing when we use the lost-time or so-called major accident as a basis for our studies and procedure.

Further, in the length of time over which experience is analyzed (usually from one month to one year), the average plant (or department of a plant) does not develop sufficient exposure to justify the use of the comparatively small number of serious injuries, either as an indication of progress in accident-prevention work or as a safe guide to the real causes of the predominating types of accidents.

Therefore, in basing our work in accident prevention upon the cause-analysis of major injuries alone, we not only over-estimate the importance of the accidents that produced them (and thus limit our field of research) but we also find them seriously misleading when we try to determine the proper corrective action to be taken. These facts become readily apparent when we consider that the major injury does not always result from the first accident in the series of which it is a part. It may occur as a result of the last accident, or at any intermediate point, or it may be the result of an exceptional isolated accident-type that might never occur again. Basic truths determined by averaging a sufficient spread of data, are always of greater value than assumptions having a basis in isolated cases selected chiefly because they are spectacular.

Some years ago, in a certain community close to the waterfront, more than 1,000 persons became ill within a period of a week, and one person died. An autopsy held over the deceased indicated uremia, probably aggravated by impure food, and the circumstances pointed to shellfish as a cause of the trouble. The authorities acted promptly, but not until several other persons had become seriously ill was it discovered that the first fatality was not indicative of the real cause of the epidemic—as a matter of fact, the town water was polluted.

I use this incident to illustrate two points:

First—The real *source* of the *majority* of ills is a better guide to action in case of an epidemic, than is the source of an isolated case which may be selected chiefly because it is spectacular, or because it results seriously.

Second—An ailment of any kind, whether it is of major or minor gravity, may be potentially serious; and the indications of the greater volume of minor cases are vitally significant in the treatment of plagues and epidemics, and as a guide to the safeguarding not only of the individual but of the community as well.

The existing situation in the work of preventing accidents is somewhat similar. The occurrence of accidents is frequent enough to warrant comparison with plagues or epidemics. When fatalities or serious injuries occur in industry we hold courts of inquiry, state authorities require reports of compensable cases, and, in general, attention is concentrated upon these serious injuries while the vastly greater volume of minor cases, whose significance as a whole is more pointed, is practically ignored.

As an incidental to our cause-analysis of 75,000 accidents, it has already been determined that the ratio of minor injuries to major injuries is 29 to 1.

In continuing our analysis, we now are able to present information of still more vital significance to those interested in furthering this important humanitarian and economic work of industrial-accident prevention.

Much has been said of near accidents—meaning those that produce no injury whatever, although having the potential power to do so. These improper occurrences—these errors of judgment, defects, slips and fumbles; these so-called near accidents—because of their proportionately greater volume, present to the capable supervisor who is intelligent enough to take advantage of it, a splendid opportunity to anticipate and prevent actual injuries.

The number of such no-injury or potential-injury accidents in comparison to actual injuries has always been a nebulous quantity, and it probably will never be known exactly. Nevertheless, TRAVELERS engineers have arrived at a minimum which in itself is so high that it proves conclusively the necessity for supervisory control enforced through adequate executive participation. It substantiates the belief that *the foreman is the key man* in industrial accident-prevention work. It ties in even more closely and forcibly the relation of profitable production and accident prevention, since (as THE TRAVELERS has already demonstrated) the real causes of accidents are likewise the real causes of decreases in efficiency, production, and profits. In short they denote conditions that are morally and economically improper.

As previously indicated, *for each personal injury of any kind (regardless of severity) there are at least ten other accidents*; furthermore, because of the relative infrequency of serious injuries, there are 330 *accidents*

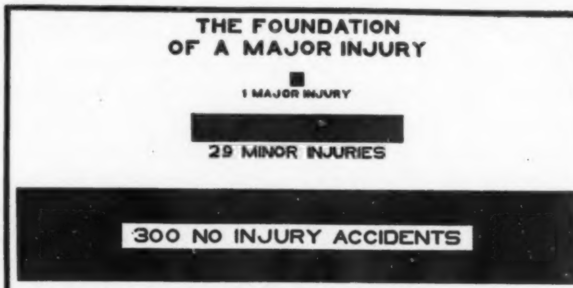
which produce only one *major injury* and 29 *minor injuries.* In view of these facts, it should be ovious that present-day accident-prevention work is misdirected, because it is based largely upon the analysis of one major injury—the 29 minor injuries are recorded (but seldom analyzed) and the 300 other occurrences are, to a great extent, ignored.

That this picture is not overdrawn may be better realized when we consider that in the unit accident group (330 cases) shown on the accompaning chart, under the caption *"The Foundation of a Major Injury,"* a major accident is any case that is reported to insurance carriers or to the State Compensation Commissioner, and that the great majority of these reported or so-called major accidents are not fatalities nor fractures nor dismemberments; they do not all involve lost time, nor are they all lost-time accidents in the sense that compensation is paid. Considering all these facts, it may readily be deduced that an analysis as to cause and remedial action, that is based upon one *fatal* or *lost-time* or *permanent injury* (or so-called major-accident case) out of a total of 330 potential injuries, is limited and misleading.

The truth of this deduction is strikingly demonstrated through the discovery—also recorded on the chart—that the frequency of major injuries varies directly with the frequency of no-injury or potential-injury accidents. This result would naturally be expected to follow, inasmuch as the predominant causes of no-injury accidents are, in average cases, identical with the predominant causes of major injuries—and incidentally of minor injuries as well.

The determination of this no-injury accident frequency followed a most interesting and absorbing study. The difficulties can readily be imagined. There are few existing data on minor injuries—to say nothing of no-injury accidents. Case after case was discarded because of lack of information. Many others were included at a one-to-one ratio (first accident produced an injury), knowing at the same time that in all probability there had been dozens, or perhaps hundreds, of previous no-injury occurrences. Nevertheless, each injury case was included, where there was any substantial indication whatever of the existence or lack of prior accidents.

It was also necessary to place a practical limitation upon the data. For example, an injury resulted from a mechanical defect. This defect had existed throughout the life of the machine. Over a period of several years, each revolution of the machine had exposed the operator to an injury. Finally, the exact balance of variable circumstances occurred, and an injury resulted. This did not fall within our practical limitation, and was rejected. In other rejected cases employees were assigned to work for which, by temperament and ability, they were unsuited, and were ultimately in-



THE RATIOS GRAPHICALLY PORTRAYED ABOVE----1----29---300------
WHEN EXPRESSED IN PERCENT OF ALL ACCIDENTS SHOW THAT-------
00.3% OF ALL ACCIDENTS PRODUCE MAJOR INJURIES----------------
08.8% OF ALL ACCIDENTS PRODUCE MINOR INJURIES----------------
90.9% OF ALL ACCIDENTS PRODUCE NO INJURIES-------------------

THE TOTAL OF 330 ACCIDENTS AS SHOWN BY THE TABLE BELOW ALL HAVE THE SAME CAUSE.
SINCE IT IS TRUE THAT THE ONE MAJOR INJURY MAY RESULT FROM THE VERY FIRST ACCIDENT OR FROM THE LAST OR FROM ANY OF THOSE THAT INTERVENE, THE OBVIOUS REMEDY IS TO ATTACK ALL ACCIDENTS.

ANALYSIS OF
50,000 INJURIES BY CAUSE

REAL CAUSES OF ACCIDENTS	50,000 INJURIES MAJOR INJURY	MINOR INJURY	500,000 ACCIDENTS NO INJURY	%
FAULTY INSTRUCTION	491	14509	150000	30
INATTENTION	375	10625	110000	22
UNSAFE PRACTICE	230	6770	70000	14
POOR DISCIPLINE	202	5798	60000	12
INABILITY OF EMPLOYEE	134	3866	40000	8
PHYSICAL UNFITNESS	49	1451	15000	3
MENTAL UNFITNESS	17	483	5000	1
MECHANICAL HAZARDS	168	4832	50000	10
	1666	48334	500000	100

NOTE—THIS TABLE SHOWS THAT THE CAUSES OF MINOR INJURIES AND OF NO INJURY ACCIDENTS ARE SUBSTANTIALLY THE SAME AS THE CAUSES OF MAJOR INJURIES. BY REMOVING THE REAL CAUSES OF EITHER MINOR INJURY OR NO INJURY ACCIDENTS WE THEREBY PREVENT MAJOR INJURIES AS WELL.

THE TRAVELERS INSURANCE CO.

jured as a direct result. Here again are potential injuries, but they are too intangible to record in print. In determining the ratio of 329 accidents to one major injury, we therefore included only actual visible evidences of man-failure—such as dropping or fumbling of tools or other objects, falls of persons, and unsafe practices—and were obliged to exclude practically all accidents caused by machines, even though the latter would have raised the no-injury frequency materially.

It needs but little thought for the average person to conclude that the no-injury accident ratio herein expressed is not exaggerated. How many drivers of auto-

mobiles would care to assert that they had never driven across a railroad grade crossing without being absolutely sure that no train was coming? And when injuries do so occur, what would probably be the ratio of cause to injury? When a person stumbles, falls, and sustains an injury, is it safe to say that he never fell before?

At the risk of being unnecessarily verbose, we believe it advisable to defend the use of the term "accident" as properly descriptive of these slips and fumbles that produce no injuries. As already pointed out, an accident need not necessarily produce an injury. What, then, is an accident? It is an unforeseen, improper, or non-planned occurrence, or as Webster has it, "An event that occurs without one's foresight. Surely, slips and falls, fumbles and stumbles, should be included in this category. Finally, what is it that we try to remedy in our accident-prevention work other than the occurrences that produce injuries? No intelligent employee who is jealous of his physical well-being will deliberately expose himself unnecessarily to danger. On the other hand, employers will scarcely admit the propriety of countenancing practices that so clearly decrease both economy and safety. If, therefore, we know that errors of judgment, faulty instruction, inattention, and poor discipline, cause injuries as evidenced by slips and falls, then let us determine to proceed with a worthwhile work on a newer and more effective basis. By concentrating upon the prevention of *accidents* rather than *injuries*, and through recognition of the fact that no accident, whether or not it results in an injury, is too insignificant to receive consideration, we may hope to attack successfully a problem that has become one of the most serious that ever confronted the executives of industry.

Here are a few of the specific cases from which the ratios previously mentioned were determined:

EXAMPLE 1. An employee in going to and from work, took a short cut which obliged him to climb a fence and cross a railroad siding that was a part of the plant premises. Cars spotted at this point, frequently prevented a clear vision of the tracks, and the noise of the plant machinery (24-hour operation) made it hard to hear warning whistles and bells. One day, at noon, this man stepped from behind a freight car directly into the path of an oncoming engine. Crossing the tracks at this point was forbidden and notices to that effect were posted. A fence was provided. Traimen used whistles and bells. In short, the situation was normal, except for non-enforcement of instructions. The employee admitted that he had crossed the tracks four times a day for two and one-half years —or approximately 3,000 times—prior to his injury.

EXAMPLE 2. A mill employee slipped and fell on a wet floor and fractured his kneecap. For more than six years it had been the practice to wet down too great an area of floor space at one time, and to delay unnecessarily the process of wiping up. Slipping on the part of one or more employees was a daily occurrence. The ratio of no-injury slips to the injury, was 1,800 to 1.

EXAMPLE 3. In splitting a board, a circular-saw operator suffered the loss of his thumb when, in violation of instructions, he pushed the board past the saw with his fingers, instead of using the push stick that had been provided for the purpose. He stated that he had always done such work in this manner, and had never before been hurt. He had performed similar operations on an average of 20 times a day for three months, and had therefore exposed his hand in this way over 1,500 times.

EXAMPLE 4. A millwright attempted to put a 5-inch belt on a revolving pulley 24 inches in diameter. He was caught and killed. Investigation indicated that this method of shipping the belt had been employed daily for several years. The ratio of cause-occurrence to injury, here, is 600 to 1.

It is perhaps unnecessary to say that there are instances in which an injury occurs the very first time an error is made, and that the examples selected for illustration, while of frequent occurrence, are probably also abnormal. The ratio of 10 to 1, however, which actually results from our research, is, in our opinion, ultroconservative.

Since these potential-injury accidents are all occurrences that may readily be observed, it is apparent that an alert supervisor—one who has the interests of both employee and employer at heart—has a splendid opportunity to check accident-producing conditions long before an injury actually happens.

Potential-injury accidents not only eventually endanger an individual, but also frequently lead to disasters that take the lives of many persons at once. This is illustrated by the following:

EXAMPLE 5. Seventeen passengers in a motorbus were killed or seriously injured, when a fire occurred while the bus was being fueled. The gasoline-station attendant was an inveterate cigar smoker, and invariably failed to remove the cigar from his mouth when filling gas tanks. The ratio of cause-occurrence to injury in this case, was undoubtedly several thousand to one.

Other recorded instances show that no-injury accidents eventually lead to explosions, fires and resultant panics, wrecks, and other catastrophes that cause tremendous loss of life.

We believe that the foregoing statements and figures furnish convincing proof of the unsoundness of the theory that serious injuries, or major accidents (as industry now erroneously terms them), should be made the basis of accident-prevention work; on the other hand, they also show that, on the average, accidents of various kinds are of equal weight. Moreover, the natural conclusion follows that in the largest accident group—namely, the minor accidents—we are likely to find our most valuable clue as to causes which should be removed through effective prevention work.

In making a survey of one hundred typical manufacturing plants, we found that in the majority of them the causes of the serious injuries, over a given period, did not fairly picture the unsafe conditions needing first attention. Therefore, accident-prevention work in these plants was misdirected (since it was based largely upon the investigation of these major injuries) and many other serious injuries of a slightly different nature later occurred.

It would be unfair to many progressive and clear-thinking plant executives to infer that this is universally true. As a matter of fact, it has been partly through the cooperation of certain employers who are now concentrating on minor injuries, and a study of the data furnished by them, that we have been able to substantiate much of the theory that forms the basis of this article.

Undoubtedly a healthy condition exists when attention is concentrated upon the prevention of fatalities and serious injuries. This work should not be neglected, but we maintain that the general problem will be more speedily solved if the causes of *all* injuries, regardless of severity, are first selected as a basis for our work, and then with a clearer knowledge of the frequency and the significance of no-injury or potential-injury cases, accident prevention is more intimately merged with routine industrial work through the enforcement of supervisory responsibility.

Industry and society suffer today because of errors. A slip is made; poor judgment, inattention, and man-failure exist and eventually an injury occurs. We have been able to estimate the annual economic loss to employers alone, at ten billion dollars. The physical suffering and mental anguish that also result from industrial accidents can never be measured in monetary terms. Scientific accident prevention will solve the industrial-accident problem, and in this study of existing preventive methods, as made by TRAVELERS engineers, we are confident that there is a clue to more satisfactory progress.

Research Planned on Light-Weight Aggregates

METHODS of production of light-weight aggregates for concrete will be studied in research undertaken by the Bureau of Mines, the Department of Commerce has just announced.

The decrease in dead weight resulting from the use of these materials effects a considerable saving in the cost of constructing large buildings, bridges, etc., it was pointed out in the statement, which follows in full text:

Methods for the production of light-weight aggregates for concrete have been the subject of numerous patents since 1867, the Department points out. It is, however, only recently that the industrial importance of such materials has been fully appreciated. Low-grade clays, shales, and shale rock when heated rapidly at about 2,000 degrees F. for a short period of time expand to 2½ to 3 times their original volume.

Material sintered in this fashion when subsequently crushed and used as concrete aggregate yields concrete of the same or somewhat larger compressive strength and of only two-thirds the weight of concrete made with ordinary rock and sand aggregate. The decrease in dead weight resulting from the use of these materials effects a considerable saving in the cost of structural steel for large buildings, bridges, etc.

In view of the importance of this new industry as evidenced by the number of inquiries concerning the deposits of clays and shale available for the manufacture of light-weight concrete aggregate, the Non-Metallic Minerals Experiment Station of the Bureau of Mines, in cooperation with the Ceramics Department of Rutgers University at New Brunswick, N. J., is planning to start a survey of such deposits, and a laboratory investigation of the fundamental factors involved in the manufacture of these aggregates.

Accident Prevention from an Economic Standpoint

By Harmon T. McCartney,

Chairman, Committee on Safety and Welfare, Carbon Limestone Co., Youngstown, Ohio

Editor's Note: Many of the member companies of the National Association have undoubtedly perfected safety organizations and through such organizations accomplished remarkable results in the field of Accident Prevention. Why hide one's light under a bushel, particularly when your experiences in this line of endeavor would undoubtedly prove of distinct value to your fellow producers in advancing the common cause of Accident Prevention? The Crushed Stone Journal is the logical medium for the dissemination of such information and we would welcome articles dealing with any phase of this activity. Mr. McCartney's article should prove of decided interest and with your cooperation is the first of a series which should bring forth much valuable information.

It is with much pleasure and gratification from an economic as well as a humanitarian standpoint, that I submit the following results of Safety First work, as accomplished by our Safety Organization, covering a period of the past ten years.

The humanitarian side of Safety is or should always be uppermost in the minds of any safety organization. The accidents causing loss of life and limb, the loss of the earning power of the bread winner, the children and widow left without support and eventually becoming charges upon society in general, are regrettable results, and are the accidents which most corporations and companies are doing their utmost to prevent.

But the fact has been proven without doubt, that in preventing these accidents, every company or institution is deriving a more or less economic value which eventually helps to increase the profits of that concern.

I have had the privilege of being Chairman of the Committee on Safety and Welfare of one of the largest limestone quarries and manufacturing plants in western Pennsylvania, and covering a period of ten years we have reduced our Liability Insurance rate every year, until now it is less than half what it was in 1918.

In the year 1918, our company like many others was lax as regards safety practice. We had no organized Safety Committee, no one in particular had charge of the Safety Work. It was simply a matter of "watch your step," a slogan at that time. This "watching your step" individually, took a lot of the employee's time as well as being extremely expensive to the company. So after a conference of the Directors of our company, and an unusual number of accidents, it was decided to create an organized Safety Committee with a permanent chairman. We immediately organized a committee of eighteen members, consisting of heads of all departments, a few employees, and our superintendents. This Committee has always worked together faithfully and harmoniously, to one end, the ultimate completion of recommendations that will lead to the elimination of accidents. At first we found a great many places and conditions which needed our attention, but as we continued to properly guard our machinery and place safety signs where needed, and with the elimination of other likely defects, and the educating of employees as to Safety, the results were quickly noticeable and gratifying and our accidents markedly reduced.

Our organization owes a great deal to the Pennsylvania Department of Labor and Industry, for their untiring efforts along the lines of Safety.

We receive annually from the Rating Bureau, the rates applying to our limestone plant. After receiving the report of the Rating Bureau, we at once carefully go over same and see if we cannot remedy some conditions and secure from said bureau, a credit on that certain point. This we find we can sometimes do, thereby reducing our rate quite materially. The checking over of penalties on the Rating Bureau's report and the possible elimination of same is one of the greatest factors in the reduction of insurance rates and it should be the first duty of the Safety Committee to see that this is done.

We also do our utmost to eliminate fatalities, which are always regrettable and constitute a very expensive item in the compiling of our insurance rates.

On January 24th, 1928, we received a letter from Mr. Charles A. Waters, Secretary of Labor and Industry of the State of Pennsylvania, saying that he was very much gratified to report that during the year 1927, the reports show a reduction of compensation paid, of nearly eleven per cent over that of 1926. In this same letter he states the Department of Labor and Industry is ready at all times to supply speakers on Safety. We

(*Continued on page* 16)

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The Trade Association a Vital Force in American Business

PROBABLY no other single factor has contributed as much to the economic welfare of American Business today as has the trade association. With the increasing keenness of competition not only between the members of the same industry, but more particularly between competing industries, each day shows more clearly than its predecessor that the ultimate answer can only be obtained through cooperative group action or in other words, the trade association. From every side we hear of the increasing importance which is rightfully being attributed to the trade association and it is gratifying to be able to realize that it is rapidly being recognized as one of the vital and indispensable elements in the economic set-up of the country.

George H. Charls, president of the National Association of Flat Rolled Steel Manufacturers, in speaking before the Pressed Metal Institute in Buffalo last October cites some convincing and impressive examples of the attitude in which trade associations are regarded today and also gives voice to his own opinions in this regard. The following quotation is taken from Mr. Charls' Buffalo address:

A well-directed trade association is the fourth leg of the chair upon which business rests. If this leg fails, the business fails.

This opinion, voiced by Dr. Hollis Godfrey, chairman of the board and president of the Engineering-Economics Foundation of Boston, carries with it substantiating opinions from the far-seeking and best equipped business executives and economists in the world of business today.

The pivotal position occupied by trade associations in commerce is being recognized as a potential factor in the business life of all industry.

Herbert Hoover, Republican candidate for Presidency, and then Secretary of Commerce, in the 1927 book of the Department of Commerce on trade association activities, states:

"Trade associations have made a most valuable contribution to our economic progress.... Within the last few years, they have rapidly developed into legitimate and constructive fields of utmost public interest and have marked a fundamental step in the greatest evolution of our economic life."

The Equitable Trust Co., New York, has this to say about trade associations:

"Factors making for business improvement are factors lessening credit risks and increasing the demand for banking facilities.... The modern trade association is one of these factors."

Abram F. Meyers, Federal Trade Commissioner, declares:

"The old order changeth and economists and statesmen today recognize that our great national prosperity cannot be maintained on principals of 'Jungle Competition'; that its perpetuation necessarily entails some measure of stabilization of production and employment.... The industry that possesses a strong trade association is equipped for self-regulation in a degree, which, if wisely directed, will effectively preclude governmental interference by rendering it unnecessary."

A New York banker said recently:

"The time is coming when a bank's committee will ask of the applicant of a loan, 'Is he a member of a Trade Association?' In other words, is he going it alone, trying to meet this intensive age without the help of his partners in the industry?"

Set this down as gospel:

The work of the world today is being done by groups. The "new competition" has pitted industry against industry, community against community. In this world of modern business with its complexities no man can stand alone.

From an investor's standpoint:

"The poorest investment we can imagine today is a first mortgage bond on a business in an industry that has a feeble trade association or none at all. It would be mighty poor security to put away and forget."

The progressive executive of today is keenly alive to the beneficial results which can be accomplished through collective and associated effort, because it has come to pass that only through such associated effort can there be consummated the

good of the whole, the forging of unified practice, the creation of right opinions and judgment. This is but a crystallization of an opinon of an ancient philosopher, who held:

"A group survives in competition or conflict with another group according to its unity and power; according to the ability of its members to cooperate for common ends."

There are some outstanding associations which appear to have grasped the idea of success through unity and power; the willingness and ability of their membership to co-operate for common ends. Many others are in the formative period, struggling with an unthoughtful membership—obstructionists and destructionists.

Merle Thorpe, in *Nation's Business*, classified these members as follows:

"They are the unwitting economic 'throwbacks,' freaks who have sloughed off generations of development and reverted to form. They become selfish members of a community or trade, suspicious of each other, as it was in the beginning of things. Such men lose materially and spiritually."

The fundamental reason why a trade association is the fourth leg of the chair upon which industry rests is because only through scientific research and analysis can an industry develop what ought to be done in order that its membership may be sensible in the conduct of its business.

Trade associations mean contact and only in contact can intelligence and enterprise be organized and directed for the good of the whole; only through contact can the experience of the individual find a blazed trail to broader and more complete experience.

Trade associations temper destructive competition because they beget comparison, analysis and thought; uncover assumptions and question certainties. Competition with no contact merely begets egotism, ignorance and chaos. Only through a trade association can an industry find the ideal, the vision, of what ought to be.

A live wire, with a broken contact, is no more dangerous to the welfare of the public than such a live wire in the form of a business executive without contact, can be dangerous to the welfare of an industry. The contact afforded by trade associations to the executives of industry is of vital concern to the stockholders, the workers, the consuming public, to the purchasing power of the nation and to the perpetuation of prosperity.

To be specific, the National Crushed Stone Association is the organization representing the business men of the United States and Canada who are engaged in the production of crushed stone. The National Crushed Stone Association is the fourth leg of the chair upon which the crushed stone industry rests and it behooves every individual member of the industry to lend his assistance, both moral and financial, to the end that this necessary element of support be maintained in a sound, vigorous, and healthy condition.

The part which the National Association has played in the affairs of the industry is known to all and no fair minded producer can say that the activities of the Association have not been of inestimable value to the welfare of the industry. There is not one who would willingly see conditions revert to such as were in existence before the industry organized in 1918.

Mr. Non-Member, do you realize that the National Association is constantly endeavoring to assist you in the marketing of your product; that investigations being conducted in the Association's research testing laboratory are continuously yielding information vital to you in the intelligent sale of your material, and that the Association stands ready and willing to help you in car shortage difficulties, freight matters and in fact in any way in which it can be of assistance.

The Association is working for your interests, striving to improve conditions throughout your industry and cannot help but feel on the face of the record so far established that it merits your whole-hearted and sympathetic support both morally and financially.

The field of usefulness of our activities is constantly increasing and if we are to be able to meet these growing demands, the support of every producer is vitally necessary. The Association needs you and we earnestly and sincerely believe that you need the Association.

We most cordially invite all non-members to immediately join. Application blanks for membership as well as any additional information which might be desired can be obtained by writing to the Secretary's Office, 1735 14th St., N. W., Washington, D. C.

A. S. T. M. Symposium on Mineral Aggregates

THE American Society for Testing Materials announces as a portion of the program of the annual meeting to be held at Atlantic City, June 25-28, a "Symposium on Mineral Aggregates" which should be of considerable interest to all producers and users of aggregates.

Highway engineers will be particularly interested in papers dealing with "Methods of Inspection" by A. S. Rea, Chief, Bureau of Tests, Ohio State Highway Department; "Fine Aggregates in Concrete," by H. F. Gonnerman, of the Portland Cement Association; "Fine Aggregates in Bituminous Mixtures," by H. W. Skidmore, Chicago Paving Laboratory; "Influence of Coarse Aggregates Upon the Strength of Concrete," by F. C. Lang, Engineer of Tests and Inspections, Minnesota State Highway Department; "Influence of Coarse Aggregate Upon the Durability of Concrete," by F. R. McMillan, of the Portland Cement Association; "Effect of Aggregates Upon the Stability of Bituminous Mixtures," by Prevost Hubbard, of the Asphalt Association and "Aggregates in Low Cost Road Types," by

C. N. Conner, of the American Road Builders' Association.

The Symposium will be opened by a paper on "Organization Problems," by R. W. Crum, Director of the Highway Research Board, and Chairman of the Committee in Charge of the Program, and will close with a paper on "Needed Research in Aggregates," by F. H. Jackson, of the Bureau of Public Roads.

In addition to the above, there will be papers dealing with the "Use of Aggregates for Sanitary Filters and Railroad Ballast," by Dr. H. F. Kriege, of the France Stone Company; "Influence of Quality of Aggregates on Fire Resistance of Concrete," by Dr. S. H. Ingberg, of the Bureau of Standards; "Fine Aggregates in Mortar and Plaster," by J. C. Pearson, of the Lehigh Portland Cement Company as well as a paper by R. B. Young, of the Ontario Hydro-Electric Commission, on "Determination of the Concrete Making Value of Fine Aggregates from Water-Cement Ratio Tests."

Safety on the Air

STARTING Saturday evening, April 20, a series of safety talks will be broadcast by the National Broadcasting Company, in cooperation with the National Safety Council, from station WEAF and affiliated chain stations. The first of the series of twelve consecutive talks, will be given from 7 to 7.30 p. m., eastern standard time, while the following weekly broadcasts will be on the air from 7.15 to 7.30 p. m. each Saturday evening. Mr. Charles M. Schwab will be the first speaker and others on the program include the Hon. Robert P. Lamont, Secretary of Commerce; the Hon. James J. Davis, Secretary of Labor; Madam Schumann-Heink; Hon. Grover Whalen of New York, and Doctor Miller McClintock of Harvard University. *Don't fail to hear these talks!*

The Superintendent's Responsibility

THE superintendent of the quarry unquestionably occupies a strategic position with regard to accident prevention work. The success or failure of the accident prevention program rests largely upon his shoulders. With his sympathetic, helpful and earnest assistance success is assured and conversely if he be indifferent, careless and unsympathetic, failure is just as certain to result.

Writing in the March issue of *Safety Engineering*, Max Bauman, member of the Committee on Accident Prevention, Builders Trades Employers' Association, lists the following six jobs which the superintendent or foreman should perform in the interests of accident prevention.

1. Sort his men into classes to which they belong so as to help him in his safety program.
2. Give specific directions to his men as to the proper and safe methods of work.
3. Start his men off on a job, especially the new men, with a full knowledge of the hazards of the particular piece of work, and not to leave that job until he feels that the men understand.
4. Do every job he has any personal hand in doing the safe way always so as to set the right example to his men.
5. Check up his working force continuously and regularly to make sure that his safety instructions are lived up to.
6. Reprimand any and all workmen who break a safety rule.

Accidents throughout the crushed stone industry must be reduced and we believe, Mr. Quarry Superintendent, that your part in this undertaking is clearly indicated. We are counting on your whole-hearted cooperation.

Accident Prevention from an Economic Standpoint

(*Continued from page* 13)

have accepted this offer and have had Safety talks by members of this department. We hold special meetings for all employees semi-annually, at which time we have these special speakers, and their talks always give our employees food for thought, and they show an extra effort along the lines of Safety.

With the continued careful practice of Safety, combined with the faithful and untiring efforts of our Safety Committee, we are producing very gratifying economic results as well as humanitarian ones.

Let us not forget that the greatest aim of safety work must always be for the prevention of injury and death, and the sorrows which follow.

As one writer has said:

"And the end is that the workman shall live to enjoy the fruits of his labor; that his mother shall have the comfort of his arms in her age; that his wife shall not be untimely a widow; that his children shall have a father; and that cripples and helpless wrecks, who were once strong men shall no longer be a by-product of Industry."

In conclusion, I trust that they who read this "Safety Offering" will receive at least one small thought, which will help in the great cause of Safety.